B.2.6 NORTHERN CALIFORNIA STEELHEAD ESU

Primary contributor: David Boughton
(Southwest Fisheries Science Center – Santa Cruz Lab)

B.2.6.1 Summary of Previous BRT Conclusions

The Northern California ESU was determined to inhabit coastal basins from Redwood Creek (Humboldt County) southward to the Gualala River (Mendocino County), inclusive (Busby et al. 1996). Within this ESU, both summer-run[1], winter-run, and half-pounders[2] have been found. Summer-run steelhead are found in the Mad, Eel, and Redwood rivers; the Middle Fork Eel River population is their southern-most occurrence. Half-pounders are found in the Mad and Eel rivers. Busby et al. (1996) argued that when summer-run and winter-run steelhead co-occur within a basin, they were more similar to each other than either is to the corresponding run-type in other basins. Thus Busby et al. (1996) considered summer-run and winter-run steelhead to jointly comprise a single ESU.

Summary of major risks and status indicators

Risks and limiting factors—The previous status review (Busby et al. 1996) identified two major barriers to fish passage: Mathews Dam on the Mad River and Scott Dam on the Eel River. Numerous other blockages on tributaries were also thought to occur. Poor forest practices and poor land use practices, combined with catastrophic flooding in 1964, were thought to have caused significant declines in habitat quality that then persisted up to the date of the status review. These effects include sedimentation and loss of spawning gravels. Non-native Sacramento pikeminnow (*Ptychocheilus grandis*) had been observed in the Eel River basin and could be acting as predators on juvenile steelhead, depending on thermal conditions leading to niche overlap of the two species (see also Brown and Moyle 1981, 1997; Harvey et al 2002, Reese and Harvey 2002).

Status indicators—Historical estimates (pre-1960s) of steelhead abundance for this ESU have been few (Table B.2.6.1). The only time-series data are dam counts of winter-run steelhead in the upper Eel River (Cape Horn Dam, 1933-present), winter-run steelhead in the Mad River (Sweasey Dam, 1938-1963), and combined counts of summer-run and winter-run steelhead in the South Fork Eel River (Benbow Dam, 1938-75; see Figure B.2.6.1A). More recent data are snorkel counts of summer-run steelhead that were made in the middle fork of the Eel since 1966 (with some gaps in the time-series) (Scott Harris and Wendy Jones, CDFG, personal communication). Some "point" estimates of mean abundance exist—in 1963, the California Department of Fish and Game made estimates of steelhead abundance for many rivers in the

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[1] Some consider summer-run steelhead and fall-run steelhead to be separate runs within a river while others do not consider these groups to be different. For purposes of this review, summer-run and fall-run are considered stream-maturing steelhead and will be referred to as summer steelhead (see McEwan 2001 for additional details).

[2] A half pounder is a sexually immature steelhead, usually small, that returns to freshwater after spending less than a year in the ocean (Kesner and Barnhart 1972, Everest 1973).

ESU (Table B.2.6.2). An attempt was made to estimate a mean count over the interval 1959 to 1963, but in most cases 5 years of data were not available and estimates were based on fewer years (CDFG 1965); the authors state that "estimates given here which are based on little or no data should be used only in outlining the major and critical factors of the resource" (CDFG 1965). The previous BRT (Busby et al. 1996) considered the above datasets in making their risk assessment.

Table B.2.6.1. Summary of historical abundance (average counts) for steelhead in the Northern California evolutionarily significant unit (see also Figure 1).

		Average count						
Basin	**Site**	**1930s**	**1940s**	**1950s**	**1960s**	**1970s**	**1980s**	**Reference**
Eel River	Cape Horn Dam	4,390	4,320	3,597	917	721	1,287	Grass 1995
Eel River	Benbow Dam	13,736	18,285	12,802	6,676	3,355	-	
Mad River	Sweasey Dam	3,167	4,720	2,894	1,985	-	-	

Although the data were relatively few, the data that did exist suggested the following to the BRT: 1) Population abundances were low relative to historical estimates (1930s dam counts; see Table B.2.6.1 and Figure B.2.6.1); 2) Recent trends were downward (except for a few small summer-run stocks; see Figures B.2.6.1 and B.2.6.2); and 3) Summer-run steelhead abundance was "very low." The BRT was also concerned about negative influences of hatchery stocks, especially in the Mad River (Busby et al. 1996). Finally, the BRT noted that the status review included two major sources of uncertainty: lack of data on run sizes throughout the ESU, and uncertainty about the genetic heritage of winter-run steelhead in Mad River.

Listing status

Status was formally assessed in 1996 (Busby et al. 1996), updated in 1997 (NMFS 1997) and updated again in 2000 (Adams 2000). Although other steelhead ESUs were listed as threatened or endangered in August 1997, the National Marine Fisheries Service (NMFS) allowed steelhead in the Northern California ESU to remain a candidate species pending an evaluation of state and federal conservation measures. There was a "North Coast Steelhead Memorandum of Agreement" (MOA) with the State of California, which listed a number of proposed actions, including a change in harvest regulations, a review of California hatchery practices, implementation of habitat restoration activities, implementation of a comprehensive monitoring program, and numerous revisions to rules on forest-practices. These revisions would be expected to improve forest condition on non-federal lands. In March 1998 the NMFS announced its intention to reconsider the previous no-listing decision. On 6 October 1999 the California Board of Forestry failed to take action on the forest practice rules, and the NMFS Southwest Region (SWR) regarded this failure as a breach of the MOA, despite the fact that other state agencies, such as the California Department of Fish and Game, had complied with the MOA. The Northern California ESU was listed as threatened in June 2000.

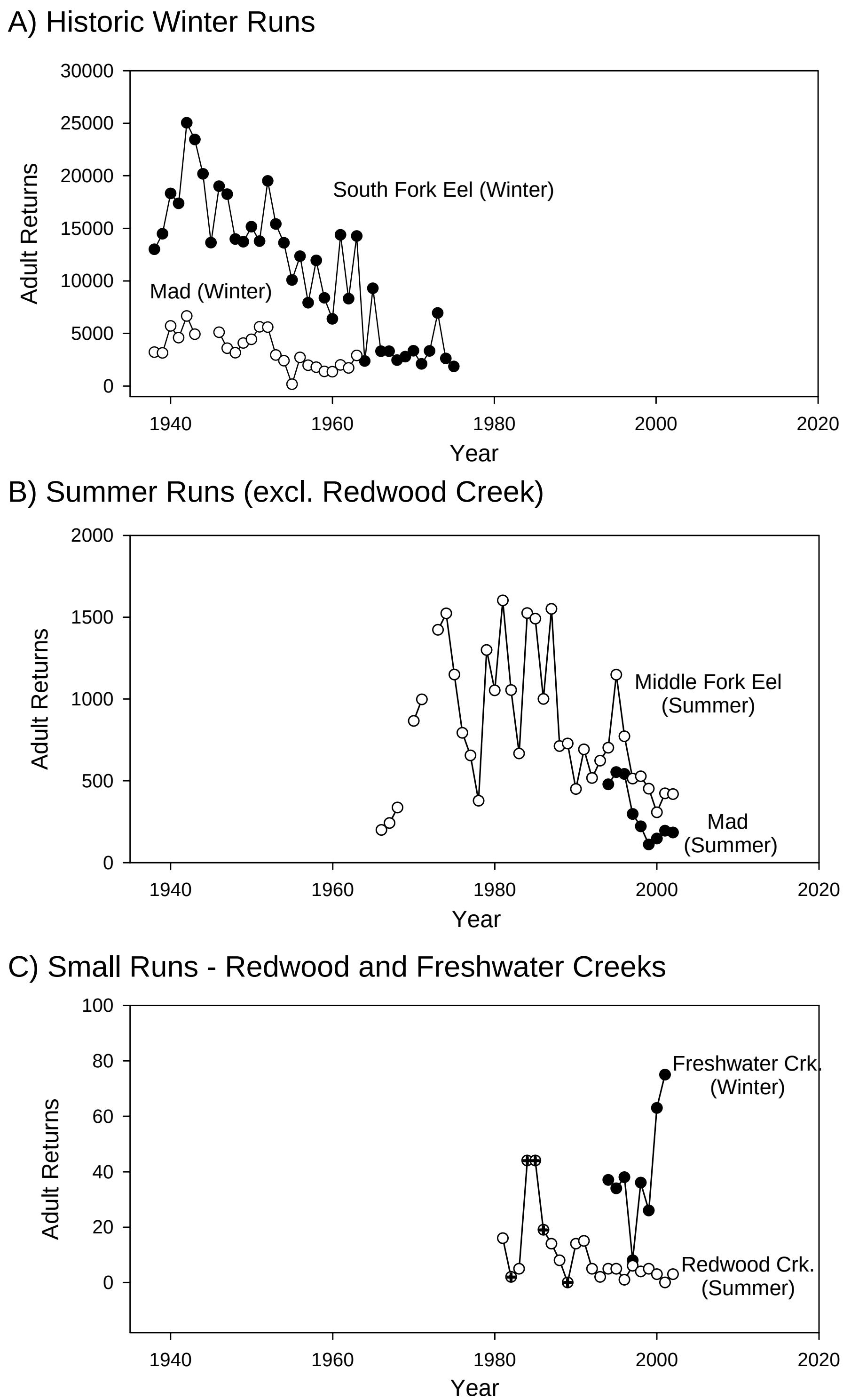

Figure B.2.6.1. Time-series data for the North-Central California Steelhead ESU. A) Historical data from winter runs on the Mad River and South Fork Eel. B) Summer-run on the Middle Fork Eel and Mad River. C) Summer-run steelhead in Redwood Creek, and winter-run steelhead in Freshwater Creek, Humboldt County. Symbols with crosses represent minimum estimates. Note the three different scales of the *y*-axis.

Table B.2.6.2. Historical estimates of number of spawning steelhead for California rivers in the Northern California ESU and Central California Coast ESU (data from CDFG 1965). Estimates are considered by CDFG (1965) to be notably uncertain.

ESU	Stream	1963
Northern California		
	Redwood Creek	10,000
	Mad River	6,000
	Eel River (total)	82,000
	Eel River	(10,000)
	Van Duzen River (Eel)	(10,000)
	South Fork Eel River	(34,000)
	North Fork Eel River	(5,000)
	Middle Fork Eel River	(23,000)
	Mattole River	12,000
	Ten Mile River	9,000
	Novo River	8,000
	Big River	12,000
	Navarro River	16,000
	Garcia River	4,000
	Gualala River	16,000
	other Humboldt County stream	3,000
	other Mendocino County streams	20,000
	Total	198,000
Central California Coast		
	Russian River	50,000
	San Lorenzo River	19,000
	other Sonoma County streams	4,000
	other Marin County steams	8,000
	other San Mateo County streams	8,000
	other Santa Cruz County streams	5,000
	Total	94,000

B.2.6.2 New Data and Updated Analyses

There are four significant sets of new information regarding status: 1) Updated time-series data exist for the middle fork of the Eel River (summer-run steelhead; snorkel counts. See Figure B.2.6.1B); 2) There are new data-collection efforts initiated in 1994 in the Mad River (summer-run steelhead; snorkel counts--Figure B.2.6.1B) and in Freshwater Creek (winter-run steelhead; weir counts--Figure B.2.6.1C; Freshwater Creek is a small stream emptying into Humboldt Bay; 3) Numerous reach-scale estimates of juvenile abundance have been made extensively throughout the ESU; and 4) Harvest regulations have been substantially changed since the last status review. Analyses of this information are described below.

Updated Eel River data

The time-series data for the Middle Fork of the Eel River are snorkel counts of summer-run steelhead, made for fish in the holding pools of the entire mainstem of the middle fork (Scott Harris and Wendy Jones, CDFG, pers. comm.). Most adults in the system are thought to oversummer in these holding pools. An estimate of λ over the interval 1966 to 2002 was made using the method of Lindley (in press; random-walk-with-drift model fitted using Bayesian assumptions). The estimate of λ is 0.98, with a 95% confidence interval of [0.93, 1.04] (see Table B.2.6.3)[3]. The overall trend in the data is downward in both the long- and the short-term (Figure B.2.6.1B).

New time-series

The Mad River time-series consists of snorkel counts for much of the mainstem below Ruth Dam. Some counts include the entire mainstem; other years include only data from land owned by Simpson Timber Company. In the years with data from the entire mainstem, fish from Simpson Timber land make up at least 90% of the total count. The time-series from Freshwater Creek is composed of weir counts. Estimates of λ were not made for either time-series because there were too few years of data to make meaningful estimates.

Vital statistics for these and other existing time-series are given in Table B.2.6.3; trend versus abundance is plotted in Figure B.2.6.2.

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[3] Note that Lindley (in press) defines $\lambda \approx \exp(\mu + \sigma^2/2)$, whereas Holmes (2001) defines $\lambda \approx \exp(\mu)$; see the Lindley (in press) for meaning of the symbols.

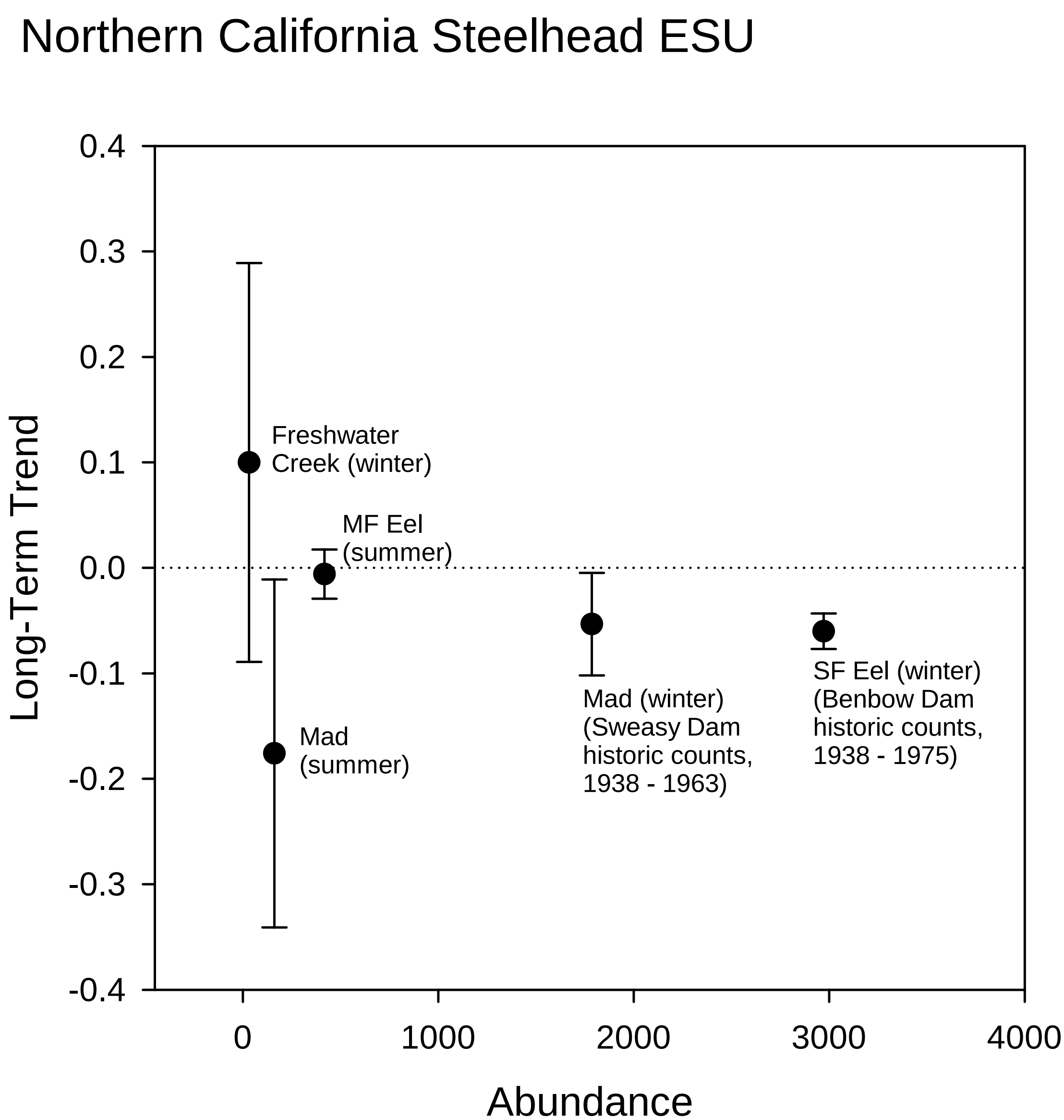

Figure B.2.6.2. Trends versus abundance for the time-series data from Figure B.2.6.1. Note that neither set of dam counts (Sweasy Dam, Benbow Dam) has any recent data. Vertical bars are 95% confidence intervals.

Table B.2.6.3. Summary of time-series data for listed steelhead ESUs on the California Coast.

Population	Span of time series	5-Year Means[4]			Lambda[5]	Long-term trend (95% conf. int.)	Short-term trend (95% conf. int.)
		Rec.	Min.	Max.			
Northern California ESU (threatened)							
M.Fk. Eel Riv. (summer-run)	’66-’02	418	384	1,246	0.98 (0.93, 1.04)	-0.006 (-0.029, 0.017)	-0.067 (-0.158, 0.024)
Mad River (summer-run)	’94-’02	162	162	384	Insufficient data	-0.176 (-0.341, -0.012)	-0.176 (-0.341, -0.121)
Freshwater Crk. (winter-run)	’94-’01	32	25	32	Insufficient data	0.099 (-0.289, 0.489)	0.099 (-0.289, 0.489)
Redwood Crk. (summer-run)	’81-’02	3	Fig. B.2.6.1[6]		Insufficient data	See Fig. B.2.6.1	-0.775 (-1.276, -0.273)
S.Fk. Eel Riv. (winter-run)[7]	’38-’75		2,743	20,657	0.98 (0.92, 1.02)	-0.060 (-0.077, -0.043)	No recent data
Mad Riv. (winter-run)[8]	’38-’63		1,140	5,438	1.00 (0.93, 1.05)	-0.053 (-0.102, -0.005)	No recent data
Central California ESU (threatened)							
No data							
South-Central California ESU (threatened)							
Carmel River (winter-run)	’62-’02	611	1.13	881	Insufficient data	0.488 (0.442, 0.538)[9]	0.488 (0.442, 0.538)
Southern California ESU (endangered)							
Santa Clara R. (winter-run)[10]	’94-’97	1.0			Insufficient data		

[4] Geometric means. The value 0.5 was used for years in which the count was zero.
[5] Lambda calculated using the method of Lindley (In press). Note that a population with lambda greater than 1.0 can nevertheless be declining, due to environmental stochasticity.
[6] Certain years have minimum run sizes, rather than unbiased estimates of run size, rendering the time series unsuitable for some of the estimators.
[7] Historical counts made at Benbow Dam.
[8] Historical counts made at Sweasy Dam.
[9] Early data (pre 1988) have exceptionally high observation error and were not used in calculations.
[10] Recent abundance is a 4-year mean.

Juvenile data

Data on juvenile abundance were collected at numerous sites using a variety of methods (contact NMFS SW Fisheries Science Ctr. for attributions of datasets). Many of the methods involve the selection of reaches thought to be “typical” or “representative” steelhead habitat; other reaches were selected because they were thought to be typical coho habitat, and steelhead counts were made incidentally to coho counts. In general, the field crew made electro-fishing counts (usually multiple-pass, depletion estimates) of the young-of-the-year and 1+ age classes. Most of the target reaches got sampled several years in a row; thus there are a large number of short time-series. Although methods were always consistent within a time-series, they were not necessarily consistent across time-series.

Because there are so few adult data on which to base a risk assessment of this ESU, we chose to analyze these juvenile data. However, we note that they have limited usefulness for understanding the status of the adult population, due to non-random sampling of reaches within stream systems; non-random sampling of populations within the ESU; and a general lack of estimators shown to be robust for estimating fish density within a reach. In addition, even if more rigorous methods had been used, there is no simple relationship between juvenile numbers and adult numbers (Shea and Mangel 2001), the latter being the usual currency for status reviews. Table B.2.6.4 describes the various possible ways that one might translate juvenile trends into inferences about adult trends.

To estimate a trend from the juvenile data, the data within each time-series were log-transformed and then normalized, so that each datum represented a deviation from the mean of that specific time-series. The normalization is intended to prevent spurious trends that could arise from the diverse set of methods used to collect the data. Then, the time-series were grouped into units thought to plausibly represent independent populations; the grouping was based on watershed structure. Finally, within each population a linear regression was done for the mean deviation versus year. The estimator for time-trend within each grouping is the slope of the regression line. The minimum number of observations per time-series is 6 years (Other assessments in this status review place the cut-off at 10 years.). The general lack of data on this ESU prompted us to consider these datasets despite their brevity.

This procedure resulted in 10 independent populations for which a trend was estimated. Both upward and downward trends were observed (Figure B.2.6.3). We tested the null hypothesis that abundances were stable or increasing. It was not rejected (H_o: slope ≥ 0; $p < 0.32$ via one-tailed *t*-test against expected value). However, it is important to note that a significance level of 0.32 implies a probability of 0.32 that the ESU is stable or increasing, and a probability of 1 – 0.32 = 0.68 that the ESU is declining; thus the odds are more than 2:1 that the ESU has been declining during the past 6 years. This conclusion requires the assumption that the assessed populations 1) are indeed independent populations rather than plausibly independent populations, and 2) were randomly sampled from all populations in the ESU (in fact they were “haphazardly” sampled).

Table B.2.6.4. Interpretation of data on juvenile trends.

		Inference made about adult trends		
		Increasing	**Level**	**Decreasing**
Observed juvenile trends	Increasing	Possible, if no density-dependence in the smolt/oceanic phase. The most parsimonious inference.	Possible, if density-dependence occurs in the juvenile over-wintering phase, or in the smolt/oceanic phase.	Possible, if oceanic conditions are deteriorating markedly at the same time that reproductive success per female is improving.
	Level	Possible, if oceanic conditions are improving for adults, but juveniles undergo density-dependence.	Possible. The most parsimonious inference.	Possible, if oceanic conditions are deteriorating.
	Decreasing	Unlikely, but could happen over the short term due to scramble competition at the spawning/redd phases.	Possible, if river habitat is deteriorating, and there was strong, pre-existing density dependence in the oceanic phase.	Likely. The most parsimonious inference.

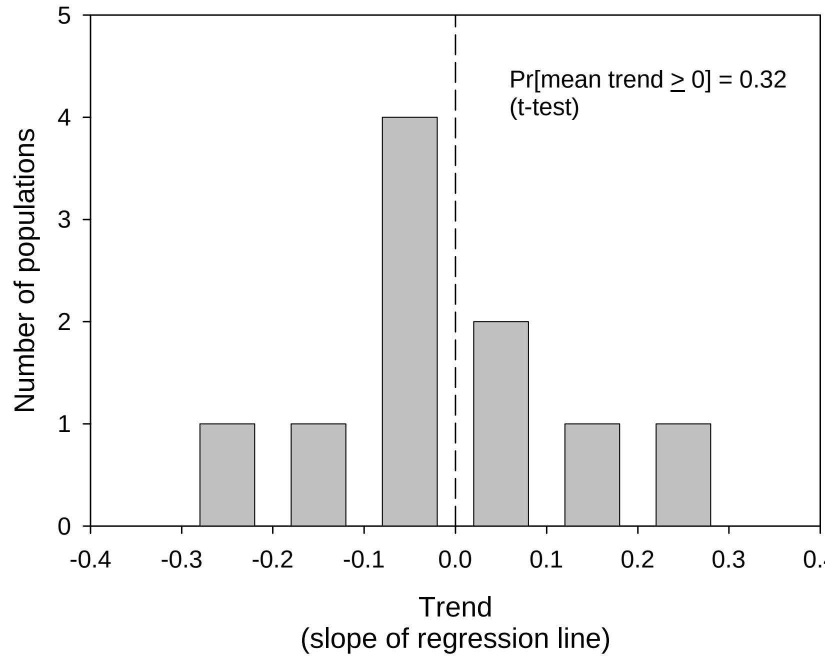

Figure B.2.6.3. Distribution of trends in juvenile density, for 10 "independent" populations within the North Coast steelhead ESU (see text for description of methods). Trend is measured as the slope of a regression line through a time-series; values less than zero indicate decline; values greater than zero indicate increase. Assuming that the populations were randomly drawn from the ESU as a whole, the hypothesis that the ESU is stable or increasing cannot be statistically rejected (p = 0.32), but is only half as likely as the hypothesis that the ESU is declining (p = 1 – 0.32 = 0.68).

Possible changes in harvest impacts

Since the original status review of Busby et al. (1996), regulations concerning sport fishing have been changed in a way that probably reduces extinction risk for the ESU.

Sport harvest in the ocean is prohibited by the California Department of Fish and Game (CDFG 2002a), and ocean harvest is a rare event (M. Mohr, NMFS, pers. comm.), so effects on extinction risk are negligible. For freshwaters (CDFG 2002b), all streams are closed to fishing year round except for special listed streams as follows: Catch-and-release angling is allowed year round excluding April and May in the lower mainstem of many coastal streams. Most of these have a bag limit of one hatchery trout or steelhead during the winter months (Albion River, Alder Creek, Big River, Cottoneva Creek, Elk Creek, Elk River, Freshwater Creek, Garcia River, Greenwood Creek, Little River in Humboldt Co., Gualala River, Navarro River, Noyo River, Ten Mile River, and Usal Creek); in a few the one-fish bag limit extends to the entire season (Bear River and Redwood Creek, both in Humboldt Co.). The Mattole River has a slightly more restricted catch-and-release season with zero bag limit year round.

The two largest systems are the Mad River and Eel River. The mainstem Mad River is open except for April and May over a very long stretch; bag limit is two hatchery trout or steelhead; other stretches have zero bag limit or are closed to fishing. Above Ruth Dam, an impassable barrier, the bag limit is five trout per day. The Eel River's mainstem and south fork are open to catch-and-release over large stretches, year round in some areas and closed April and May in others. The middle fork is open for catch and release except mid summer and late fall/winter. In the upper middle fork and many of its tributaries, there are summer fisheries with bag limits of two or five fish with no stipulated restriction on hatchery or wild. In the Van Duzen, a major tributary of the mainstem Eel, there is a summer fishery with bag limit five above Eaton Falls (CDFG 2002c). Elsewhere, some summer trout fishing is allowed, generally with a two- or five-bag limit. Cutthroat trout have a bag limit of two from a few coastal lagoons or estuaries.

At catch-and-release streams, all wild steelhead must be released unharmed. There are significant restrictions on gear used for angling. The CDFG monitors angling effort and catch-per-unit-effort in selected basins by way of a "report card" system in which sport anglers self-report their catch, gear used, and so forth, and in selected other basins by way of creel censuses.

Although the closure of many areas, and institution of catch-and-release elsewhere, is expected to reduce extinction risk for the ESU, this risk reduction cannot be estimated with existing data (due to the fact that natural abundance is not being estimated). After the Federal listing decisions, NMFS requested that CDFG prepare a Fishery Management and Evaluation Plan (FMEP) for the listed steelhead ESUs in California. This has not yet been done for the northern California ESU.

Resident *O. mykiss* considerations

Resident (non-anadromous) populations of *O. mykiss* were assigned to one of three categories for the purpose of provisionally determining ESU membership (See "Resident Fish" in the introduction for a description of the three categories and default assumptions about ESU membership). The third category consists of resident populations that are separated from anadromous conspecifics by recent human-made barriers such as dams without fish ladders. No default assumption about ESU membership was possible for Category 3 populations, so they are here considered case-by-case according to available information.

As of this writing there are few data on occurrence of resident populations and even fewer on genetic relationships. A provisional survey of the occurrence of Category 3 populations in the ESU (see Appendix B.5.2) revealed the following: In the watersheds inhabited by this ESU, 8% of stream kilometers lie behind two major recent barriers—Scott Dam on the Eel River and Robert Matthews dam on the Mad (Appendix B.5.2; major barriers are defined as blocking access to watersheds with areas of 100 sq. mi. or greater). Category 3 populations are documented to occur above both dams and there is ongoing stocking of hatchery fish in the Mad River above the dam. No such records of stocking were uncovered for the Eel above Scott Dam. There do not appear to be any relevant genetic studies of these Category 3 populations.

B.2.6.3 New Hatchery Information

California hatchery stocks being considered for inclusion in this ESU are those from Mad River Hatchery, Yager Creek Hatchery, and the North Fork Gualala River Steelhead Project. The stocks and their associated hatcheries were assigned to one of three categories for the purpose of determining ESU membership at some future date (See "Artificial Propagation" in the introduction for a description of the three categories and related issues regarding ESU membership). To make the assignments, data about broodstock origin, size, management, and genetics were gathered from fisheries biologists and are summarized below.

Mad River Hatchery (Mad River Steelhead [CDFG])

The Mad River Hatchery is located 20 km upriver near the town of Blue Lake (CDFG/NMFS 2001). The trap is located at the hatchery.

Broodstock origin and history—The hatchery was opened in 1970 and steelhead were first released in 1971. The original steelhead releases were from adults taken at Benbow Dam on the South Fork Eel River. Between 1972 and 1974, broodstock at Mad River Hatchery were composed almost exclusively of steelhead from the South Fork Eel River. After 1974, returns to the hatchery supplied about 90% of the egg take; other eggs originated from Eel River steelhead. In addition, at least 500 adult steelhead from the San Lorenzo River were spawned at Mad River Hatchery in 1972. Progeny of these fish may have been planted in the basin. All subsequent broodyears are reported to have come from trapping at the hatchery.

Broodstock size/natural population size—An average of 5,536 adults were trapped from 1991 to 2002 and an average of 178 females were spawned during the broodyears 1991-2002. There are no abundance estimates for the Mad River, but steelhead were observed to be widespread and abundant throughout the basin.

Management—Starting in 1998, steelhead are 100% marked and fish are included in the broodstock in proportion to the numbers returned. The current production goals are 250,000 yearlings raised to 4-8/lb for release in March to May.

Population genetics—Alloyzme data group Mad River samples in with the Mad River Hatchery and then with the Eel River (Busby et al.1996).

Category—The hatchery has been determined to belong in Category 3. There have been no introductions since 1974, and naturally spawned fish are being included in the broodstock. However, there is still an out-of-basin nature to the stock (SSHAG 2003; see Appendix B.5.3).

Yager Creek Hatchery (Yager Creek Steelhead [PalCo])

The Yager Creek trapping and rearing facility is located at the confluence of Yager and

Cooper Mill creeks (tributaries of the Van Duzen River, which is a tributary of the Eel River).

Broodstock origin and history—The project was initiated in 1976. Adult broodstock are taken from Yeager Creek and juveniles are released in the Van Duzen River basin. As with all Co-operative hatcheries, the fish are all marked and hatchery fish are usually excluded from broodstock (unless wild fish are rare). There are no records of introductions to the broodstock.

Management—About 4,600 juvenile steelhead from Freshwater Creek (a tributary of Humboldt Bay) were released in the Yager Creek Basin in 1993 (Busby et al. 1996). The current program goal is the restoration of Van Duzen River Steelhead.

Population genetics—There are no genetic data for this hatchery.

Category—This hatchery was determined to belong to Category 1. The broodstock has had no out-of-basin introductions and hatchery fish are excluded from the broodstock (SSHAG 2003; see Appendix B.5.3).

North Fork Gualala River Hatchery (Gualala River Steelhead Project [CDFG/Gualala River Steelhead Project])

This project rears juvenile steelhead rescued from tributaries of the North Fork Gualala River. Rearing facilities are located on Doty Creek, a tributary of the Gualala River 12 miles from the mouth. Steelhead smolts resulting from this program are released in Doty Creek, the mainstem of the Gualala River, and other locations in the drainage.

Broodstock origin and history—The project was started in 1981 and has operated sporadically since then. Juvenile steelhead are rescued from the North Fork of the Gualala River and reared at Doty Creek.

Management—The current program goal is restoration of Gualala River steelhead.

Population genetics—There are no genetic data for this hatchery.

Category—Determined to be Category 1. Usually only naturally spawned juveniles are reared at the facility (SSHAG 2003; see Appendix B.5.3).

B.2.7 CENTRAL CALIFORNIA COAST STEELHEAD

Primary contributor: David Boughton
(Southwest Fisheries Science Center – Santa Cruz Lab)

B.2.7.1 Summary of Previous BRT Conclusions

The Central California Coast ESU was determined to inhabit coastal basins from the Russian River (Sonoma County), to Soquel Creek (Santa Cruz County) inclusive (Busby et al. 1996). Also included in this ESU are populations inhabiting tributaries of San Francisco and San Pablo bays (though there is some uncertainty about the latter). The ESU is composed only of winter-run fish.

Summary of major risks and status indicators

Risks and limiting factors—Two significant habitat blockages reported by Busby et al. (1996) are the Coyote and Warm Springs Dams in the Russian River watershed; data indicated that other smaller fish passage problems were widespread in the geographic range of the ESU. Other impacts noted in the status report were: urbanization and poor land-use practices; catastrophic flooding in 1964 causing habitat degradation; and dewatering due to irrigation and diversion. There has been no formal analysis of the relative strengths of these various impacts. Principal hatchery production in the region comes from the Warm Springs Hatchery on the Russian River, and the Monterey Bay Salmon and Trout Project on a tributary of Scott Creek. At the time of the status review there were other small private programs producing steelhead in the range of the ESU, reported by Bryant (1994) to be using stocks indigenous to the ESU, but not necessarily to the particular basin in which the program was located. There was no information on the actual contribution of hatchery fish to naturally spawning populations.

Status indicators—One estimate of historical (pre-1960s) abundance was reported by Busby et al. (1996): Shapovalov and Taft (1954) described an average of about 500 adults in Waddell Creek (Santa Cruz County) for the 1930s and early 1940s. A bit more recently, Johnson (1964) estimated a run size of 20,000 steelhead in the San Lorenzo River before 1965, and CDFG (1965) estimated an average run size of 94,000 steelhead for the entire ESU, for the period 1959-1963 (see Table B.2.7.5 for a breakdown of numbers by basin). The analysis by CDFG (1965) was compromised by the fact that for many basins, the data did not exist for the full 5-year period of their analysis. The authors of CDFG (1965) state that "estimates given here which are based on little or no data should be used only in outlining the major and critical factors of the resource."

Recent data for the Russian and San Lorenzo Rivers (CDFG 1994, Reavis 1991, Shuman 1994[11]; see Table B.2.7.5) suggested that these basins had populations smaller than 15% of the size that they had had 30 years previously. These two basins were thought to have originally contained the two largest steelhead populations in the ESU.

[11] The basis for the estimates provided by Shuman (1994) appears to be questionable.

A status review update conducted in 1997 (NMFS 1997) concluded that slight increases in abundance occurred in the 3 years following the status review, but the analyses on which these conclusions were based had various problems, including inability to distinguish hatchery and wild fish, unjustified expansion factors, and variance in sampling efficiency on the San Lorenzo River. Presence/absence data compiled by P. Adams (SWFSC, personal communication) indicated that most (82%) sampled streams (a subset of all historical steelhead streams) had extant populations of juvenile *O. mykiss*.

Table B.2.7.5. Summary of estimated runs sizes for the Central Coast steelhead ESU, reproduced from Busby et al. (1996), Tables 19 & 20.

River Basin	Estimate of Run Size	Year	Reference
Russian River	65,000	1970	CACSS (1988)
	1750 – 7000	1994	McEwan and Jackson (1996), CDFG (1994)
Lagunitas Creek	500		CDFG (1994)
	400 – 500	1990s	McEwan and Jackson (1996)
San Gregorio	1,000	1973	Coots (1973)
Waddell Creek	481	1933–1942	Shapovolov and Taft (1954)
	250	1982	Shuman (1994)[13]
	150	1994	Shuman (1994)[13]
Scott Creek	400	1991	Nelson (1994)
	<100	1991	Reavis (1991)
	300	1994	Titus et al. (MS)
San Vicente Creek	150	1982	Shuman (1994)[13]
	50	1994	Shuman (1994)[13]
San Lorenzo River	20,000	Pre-1965	Johnson (1964), SWRCB (1982)
	1,614	1977	CDFG (1982)
	>3,000	1978	Ricker and Butler (1979)
	600	1979	CDFG (1982)
	3,000	1982	Shuman (1994)[13]
	"few"	1991	Reavis (1991)
	<150	1994	Shuman (1994)[13]
Soquel Creek	500 – 800	1982	Shuman (1994)[13]
	<100	1991	Reavis (1991)
	50 – 100	1994	Shuman (1994)[13]
Aptos Creek	200	1982	Shuman (1994)[13]
	<100	1991	Reavis (1991)
	50 – 75	1994	Shuman (1994)[13]

[13] The basis for the estimates provided by Shuman (1994) appears to be questionable.

Previous BRT conclusions

The original BRT concluded that the ESU was in danger of extinction (Busby et al. 1996). Extirpation was considered especially likely in Santa Cruz County and in the tributaries of San Pablo and San Francisco Bays. The BRT suggested that abundance in the Russian River (the largest system inhabited by the ESU) has declined seven-fold since the mid-1960s, but abundance appeared to be stable in smaller systems. Two major sources of uncertainty were: 1) few data on run sizes, which necessitated that the listing be based on indirect evidence, such as habitat degradation; and 2) genetic heritage of populations in tributaries to San Francisco and San Pablo Bays was uncertain, causing the delineation of the geographic boundaries of the ESU to be uncertain. A status review update (NMFS 1997) concluded that conditions had improved slightly, and that the ESU was not presently in danger of extinction, but was likely to become so in the foreseeable future (Minorities supported both more and less extreme views on extinction risk). Uncertainties in the update mainly revolved around sampling efforts that were inadequate for detecting status or trends of populations inhabiting various basins.

Listing status

The status of steelhead was formally assessed in 1996 (Busby et al. 1996). The original status review was updated in 1997 (NMFS 1997), and the Central California Coast ESU was listed as threatened in August 1997.

B.2.7.2 New Data and Updated Analyses

There are two significant sets of new information regarding status: 1) numerous reach-scale estimates of juvenile abundance have been made for populations of the ESU, and 2) harvest regulations have been substantially changed since the last status review. Analyses of this information are described below.

Juvenile data

Data on juvenile abundance have been collected at a number of sites using a variety of methods (Alley and Assoc. 1994, 1995, 1997, 1998, 1999, 2000, 2002a, 2002b; Smith 1992, 1994a, 1994b, 1994c, 1995, 1996a, 1996b, 1996c, 1997, 1998a, 1998b, 1998c, 1999, 2000a, 2000b 2001a, 2001b, 2002). Many of the methods involve the selection of reaches thought to be “typical” or “representative” steelhead habitat. In general, the field crew made electro-fishing counts (usually multiple-pass, depletion estimates) of the young-of-the-year and 1+ age classes. Most of the target reaches got sampled several years in a row; thus there are a large number of short time-series. Although methods were always consistent within a time-series, they were not necessarily consistent across time-series.

Because there are so few adult data on which to base a risk assessment of this ESU, we chose to analyze these juvenile data. However, we note that they have limited usefulness for understanding the status of the adult population, due to non-random sampling of reaches within stream systems; non-random sampling of populations within the ESU; and a general lack of estimators shown to be robust for estimating fish density within a reach. In addition, even if more rigorous methods had been used, there is no simple relationship between juvenile numbers and adult numbers (Shea and Mangel 2001), the latter being the usual currency for status reviews. Table B.2.6.4 describes the various possible ways that one might translate juvenile trends into inferences about adult trends.

To estimate a trend in the juvenile data, the data within each time-series were log-transformed and then normalized, so that each datum represented a deviation from the mean of that specific time-series. The normalization is intended to prevent spurious trends that could arise from the diverse set of methods used to collect the data. Then, the time-series were grouped into units thought to plausibly represent independent populations; the grouping was based on watershed structure. Finally, within each population a linear regression was done for the mean deviation versus year. The estimator for time-trend within each grouping is the slope of the regression line. The minimum number of observations per time-series is 6 years (Other assessments in this status review place the cut-off at 10 years.). The general lack of data on this ESU prompted us to consider these data despite the brevity of some series.

This procedure resulted in five independent populations for which a trend was estimated (the five sites are the San Lorenzo River, Scott Cr., Waddell Cr., Gazos Cr., and Redwood Cr. [Marin Co.]). Only downward trends were observed in the five populations (Figure B.2.7.4). The mean trend across all populations was significantly less than zero (H_o: slope ≥ 0; $p < 0.022$ via one-tailed *t*-test against expected value). This suggests an overall decline in juvenile abundance, but it is important to note that such a conclusion requires the assumptions that the assessed populations 1) are indeed independent populations rather than plausibly independent populations, and 2) were randomly sampled from all populations in the ESU (they are probably better regarded as having been haphazardly sampled).

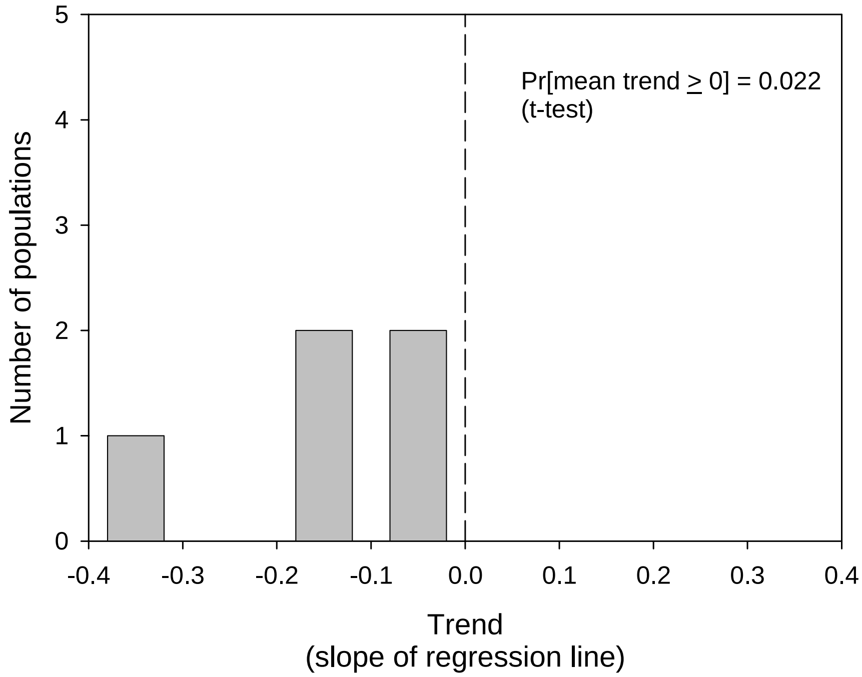

Figure B.2.7.4. Distribution of trends in juvenile densities, for five "independent" populations within the Central Coast steelhead ESU (see text for description of methods). Trend is measured as the slope of a regression line through a time-series; values less than zero indicate decline; values greater than zero indicate increase. Assuming that the populations were randomly drawn from the ESU as a whole, the hypothesis that the ESU is stable or increasing can be statistically rejected (p = 0.022); implying an overall decline.

Possible changes in harvest impacts

Since the original status review of Busby et al. (1996), regulations concerning sport fishing have been changed in a way that probably reduces extinction risk for the ESU.

Sport harvest in the ocean is prohibited by the California Department of Fish and Game (CDFG 2002a), and ocean harvest is a rare event (M. Mohr, NMFS, pers. comm.). For freshwaters (CDFG 2002b), all coastal streams are closed to fishing year round except for special listed streams that allow catch-and-release angling or summer trout fishing. Catch-and-release angling with restricted timing (generally, winter season Sundays, Saturdays, Wednesdays, and holidays) is allowed in the lower main stems of many coastal streams south of San Francisco (Aptos Creek, Butano Creek, Pescadero Creek, San Gregorio Creek, San Lorenzo River, Scott Creek, Soquel Creek). Notably, Waddell Creek in Santa Cruz Co. for awhile had a 5-per day bag limit during the winter, for the short reach between Highway 1 and the ocean; this was a mistake as the bag limit was reduced to zero in the supplementary regulations issued in a separate document (CDFG 2002c). Catch and release is allowed year round except April and May in the lower parts of Salmon Creek in Sonoma County and Walker Creek in Marin County. Russian Gulch in Sonoma County has similar regulations except that 1 hatchery fish may be taken in the winter.

The Russian River is the largest system and probably originally supported the largest steelhead population in the ESU. The mainstem is currently open all year and has a bag limit of 2 hatchery steelhead or trout. Above the confluence with the East Branch it is closed year round. Santa Rosa Creek and Laguna Santa Rosa, Sonoma County tributaries to the Russian River, have a summer catch-and-release fishery.

Tributaries to the San Francisco Bay system have less restricted fisheries. All streams in Alameda, Contra Costa, and Santa Clara Counties (east and south Bay) have summer fisheries with bag limit five, except for special cases that are closed all year (Mitchell Creek, Redwood Creek in Alameda Co., San Francisquto Creek and tributaries, and Wildcat Creek). In the north Bay, the lower mainstem of the Napa River has catch-and-release year round except April and May; there is a bag limit of 1 hatchery steelhead or trout. Upper Sonoma Creek and tributaries have a summer fishery with bag limit 5. Summer trout fishing is allowed in some lakes and reservoirs or in tributaries to lakes, generally with 2 or 5 bag limit.

For catch-and-release streams, all wild steelhead must be released unharmed. There are significant restrictions on gear used for angling. The CDFG has prepared a draft Fishery Management and Evaluation Plan (CDFG 2001a) that argues the upper limit of increased mortality due to sport fishing to be about 2.5% in all populations. This estimate is based on an estimated mortality rate of 5% once a fish is hooked, which is consistent with a published meta-analysis of hooking mortality (Schill and Scarpella 1997). Experimental studies on the subject—from which the estimates are made—tend to measure mortality only for a period of a few days or a week after capture (e.g. Titus and Vanicek 1988).

The Fishery Management and Evaluation Plan contains no extensive plans for monitoring fish abundance. Although the closure of many areas, and institution of catch-and-release elsewhere, is expected to reduce extinction risk for the ESU, this risk reduction cannot be estimated quantitatively from the existing datasets, due to the fact that natural abundance is not being measured.

Resident *O. mykiss* considerations

Resident (non-anadromous) populations of *O. mykiss* were assigned to one of three categories for the purpose of provisionally determining ESU membership (See "Resident Fish" in the introduction for a description of the three categories and default assumptions about ESU membership). The third category consists of resident populations that are separated from anadromous conspecifics by recent human-made barriers such as dams without fish ladders. No default assumption about ESU membership was possible for Category 3 populations, so they are considered case-by-case according to available information.

As of this writing there are few data on occurrence of resident populations and even fewer on genetic relationships. A provisional survey of the occurrence of Category 3 populations in the ESU (see Appendix B.5.2) revealed the following: In the watersheds inhabited by this ESU, at least 26% of stream kilometers lie behind recent barriers, and a number of resident populations are known to occur above the barriers (Appendix B.5.2). One significant set of Category 3 populations is in Alameda Creek, a tributary of San Francisco Bay. Nielson (2003) examined mitochondrial DNA and microsatellite DNA of fish from four subbasins of Alameda Creek and found that three of the subpopulations were most similar to each other and were more similar to populations from other creeks within the ESU (Lagunitas and San Francisquito creeks) than they were to populations outside the ESU. This strongly suggests that these Category 3 subpopulations should be considered part of the ESU. The fourth subpopulation, which occurred in Arroyo Mocho, was quite distinct and was more similar to Whitney hatchery stocks than it was to other subpopulations within the basin or even the wider ESU. Nielson (2003) suggests that this population may either be a population of native rainbow trout with no association to anadromous forms, or has experienced significant genetic introgression from introduced hatchery stocks.

Gall et al. (1990) examined the genetics of two populations in tributaries of the Upper San Leandro Reservoir, on San Leandro Creek. This creek drains into the San Francisco Bay and is, interestingly, the type locality for *Salmo irideus*, now known as *Oncorhynchus mykiss irideus* (Gall et al. 1990, Behnke 1992). Gall et al. (1990) analyzed genetic variability at 17 marker loci using electrophoresis, and concluded that the populations truly belonged to the coastal subspecies of *O. mykiss* (i.e. ssp. *irideus*). However, their study was not designed to assess whether the populations were more similar to hatchery stocks than to nearby wild populations. They reported anecdotal observations that the fish make steelhead-like runs to and from the reservoir.

B.2.7.3 New Hatchery Information

California hatchery stocks being considered for inclusion in this ESU are those from Don Clausen Fish Hatchery and the Monterey Bay Salmon & Trout Project. The stocks and their associated hatcheries were assigned to one of three categories for the purpose of determining

ESU membership at some future date (See “Artificial Propagation” in the introduction for a description of the three categories and related issues regarding ESU membership). To make the assignments, data about broodstock origin, size, management, and genetics were gathered from fisheries biologists and are summarized below.

Don Clausen Fish Hatchery (Warm Springs steelhead [CDFG])

The hatchery and collection site is located on Dry Creek, 14 miles above the confluence of Dry Creek and the Russian River and 47 river miles from the ocean. In 1992, the Coyote Valley Fish Facility was opened at the base of Coyote Valley Dam on the East Fork of the Russian River, 98 miles from the ocean. Both facilities trap fish on site. Coyote Valley fish are trapped and spawned there, but raised at Don Clausen Hatchery. The Coyote Valley steelhead are imprinted for 30 days at the facility before release.

Broodstock origin and history—The hatchery was founded in 1981 and the first steelhead releases were in 1982. The Coyote Valley Fish Facility was opened in 1992. Don Clausen Hatchery has had few out-of-basin transfers into its broodstock. However, significant numbers of Mad River Hatchery steelhead have been released into the basin. In the earlier part of the century, steelhead from Scott Creek were released throughout the basin. Since the Coyote Valley Fish Facility has been constructed, broodstock has been trapped at the facility.

Broodstock size/natural population size—At Don Clausen Hatchery, an average of 3,301 fish were trapped and 244 females were spawned during the broodyears 1992-2002. At the Coyote Valley Fish Facility, there have been an average of 1,947 steelhead trapped from 1993-2002 and an average of 124 females spawned. There are no steelhead abundance estimates for the Russian River, but fish are observed to be widely distributed and plentiful (NMFS, draft HGMP).

Management—As of 1998, steelhead have been 100% ad-clipped. Until broodyear 2000, both hatchery and naturally spawned fish had been included in the broodstock in the proportion that they returned to the hatchery. Since then, only adipose-marked fish are spawned and all unmarked steelhead are relocated into tributaries of Dry Creek. The production goal for Don Clausen Hatchery is 300,000 yearlings released beginning in December by size, with all fish released by April. The Coyote Valley Facility’s goal is 200,000 yearlings that volitionally release between January and March.

Category—The hatchery has been determined to belong to Category 2 (SSHAG 2003; Appendix B.5.3). Although some out-of-ESU stocks were present in the basin, there have been no significant introductions since the hatchery began operations. The stock itself has only been cultivated for 20 years. The run is abundant and naturally spawned fish were included in the broodstock until 2000. Since that time only adipose-marked steelhead have been spawned.

Monterey Bay Salmon & Trout Project (Kingfisher Flat [Big Creek] Hatchery; Scott Creek steelhead)

The Kingfisher Flat Hatchery is located on Big Creek, a tributary of Scott Creek 6 km upstream from the mouth. Broodstock are taken by divers netting adults, usually in Big Creek below the hatchery, but at times throughout the Scott Creek system (NMFS, draft Biological Opinion). Steelhead are also taken at a trap on the San Lorenzo River in Felton. San Lorenzo River steelhead are kept separately and released back into the San Lorenzo Basin.

Broodstock origin and history—The Kingfisher Flat Hatchery began in 1975. However, California state hatchery activity near this site has a long history back to 1904 (Strieg 1991). The state hatchery program ended in 1942 due to flood damage. Under the California state hatchery program, Scott Creek steelhead were widely planted throughout coastal California as they were thought to be an exceptionally healthy stock. The hatchery was damaged by floods in 1941-42 and closed. There are limited records of introductions from Mt. Shasta and Prairie Creek hatcheries into this broodstock.

In 1976, the Monterey Bay Salmon & Trout Project began operations at the Big Creek location. Since then, broodstock have been taken either in Scott Creek by divers or at a trap in the San Lorenzo River near Felton. Since that time, there have been no introductions into the broodstock. As with all Co-operative hatcheries, the fish are all marked and hatchery fish are usually excluded from broodstock. Fish are released in either Scott Creek or the San Lorenzo River depending on the source of the broodstock.

Broodstock size/natural population size—An average of 98 fish were trapped and 25 females spawned during the 1990-96 broodyears. There are no abundance estimates for Scott Creek and the San Lorenzo River, but juveniles have been observed anecdotally to be widespread and abundant (NMFS, draft Biological Opinion).

Management—Starting in 2000, the practice of planting San Lorenzo fish into the North Fork of the Pajaro River Basin was discontinued. Although the distance is only a matter of miles, it is across ESU boundaries. The current program goal is the restoration of local steelhead stocks.

Population genetics—Alloyzme data groups the Scott Creek, San Lorenzo and Carmel River stocks together (Busby et al. 1996). Collectively they fall within the "south-of-the-Russian-River" grouping.

Category—The hatchery was determined to fall into Category 1 (SSHAG 2003; Appendix B.5.3). The stock has not had out-of-basin introductions in recent years, and hatchery fish are excluded from the broodstock.

B.2.8 SOUTH-CENTRAL CALIFORNIA STEELHEAD

Primary contributor: David Boughton
(Southwest Fisheries Science Center – Santa Cruz Lab)

B.2.8.1 Summary of Previous BRT Conclusions

The geographic range of the ESU was determined to extend from the Pajaro River basin in Monterey Bay south to, but not including, the Santa Maria River Basin near the town of Santa Maria. The ESU was separated from steelhead populations to the north on the basis of genetic data (mitochondrial DNA and allozymes), and from steelhead populations to the south on the basis of a general faunal transition in the vicinity of Point Conception. The genetic differentiation of steelhead populations within the same ESU, and the genetic differentiation between ESUs, appears to be greater in the south than in Northern California or the Pacific Northwest; however the conclusion is based on genetic data from a small number of populations.

Summary of major risks and status indicators

Risks and limiting factors—Numerous minor habitat blockages were considered likely throughout the region; other typical problems were thought to be dewatering from irrigation and urban water diversions, and habitat degradation in the form of logging on steep erosive slopes, agricultural and urban development on floodplains and riparian areas, and artificial breaching of estuaries during periods when they are normally closed off from the ocean by a sandbar.

Status indicators—Historical data on this ESU are sparse. In the mid 1960s, the CDFG (1965) estimated that the ESU-wide run size was about 17,750 adults. No comparable recent estimate exists; however, recent estimates exist for five river systems (Pajaro, Salinas, Carmel, Little Sur, and Big Sur), indicating runs of fewer than 500 adults where previously runs had been on the order of 4,750 adults (CDFG 1965). Time-series data only existed for one basin (the Carmel River), and indicated a decline of 22% per year over the interval 1963 to 1993 (see below for a review of this conclusion).

Many of the streams were thought to have somewhat to highly impassable barriers, both natural and anthropogenic, and in their upper reaches to harbor populations of resident trout. The relationship between anadromous and resident *O. mykiss* is poorly understood in this ESU, but was thought to play an important role in its population dynamics and evolutionary potential. A status review update conducted in 1997 (NMFS 1997) listed numerous reports of juvenile *O. mykiss* in many coastal basins; but noted that the implications for adult numbers were unclear. They also discussed the fact that certain inland basins (the Salinas and Pajaro systems) are rather different ecologically from coastal basins.

Previous BRT Conclusions

The original BRT (Busby et al. 1996) concluded that the ESU was in danger of extinction, due to 1) low total abundance; and 2) downward trends in abundance in those stocks for which data existed. The negative effects of poor land-use practices and trout stocking were also noted. The major area of uncertainty was the lack of data on steelhead run sizes, past and present. The status review update (NMFS 1997) concluded that abundance had slightly increased in the years immediately preceding, but that overall abundance was still low relative to historical numbers. They also expressed a concern that high juvenile abundance and low adult abundance observed in some datasets suggested that many or most juveniles were potentially resident fish (i.e. rainbow trout). The BRT convened for the update was nearly split on whether the fish were in danger of extinction, or currently not endangered but likely to become so in the foreseeable future, with the latter view holding a slight majority.

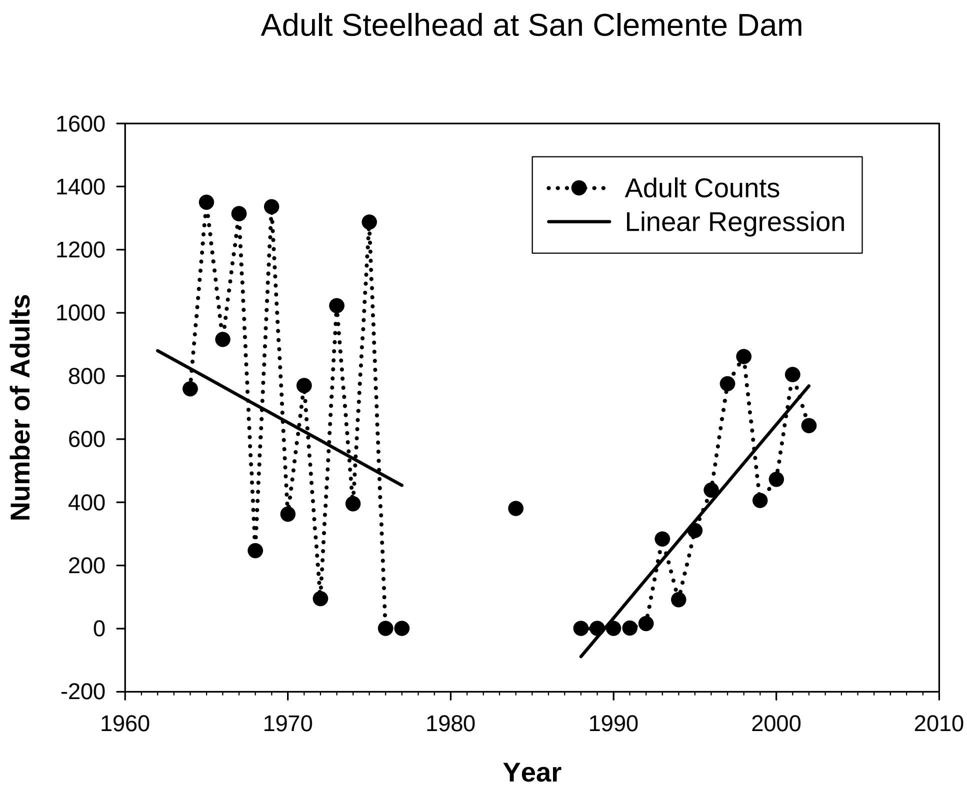

Figure B.2.8.1. Adult counts at San Clemente Dam, Carmel River. Data from the Monterey Peninsula Water Management District. See Snider (1983) for methods of counting fish before 1980; these early data are subject to substantial observation error (*N.B.* the regression line is not significantly different from flat). The increase during the 1990s followed a severe drought (and concurrent dewatering of the mainstem by a water district) in the late 1980s and early ‘90s.

Listing Status

The ESU was listed as threatened in 1997.

B.2.8.2 New Data and Updated Analyses

There are three new significant pieces of information: 1) updated time-series data concerning dam counts made on the Carmel River (MPWMD 2002) (See analyses section below for further discussion); 2) a comprehensive assessment of the current geographic distribution of *O. mykiss* within the ESU’s historical range (Boughton & Fish MS; see next paragraph); and (3) changes in harvest regulations since the last status review (see next section).

Table B.2.8.1. Estimates of historical run sizes from the previous status review (Busby 1996).

River Basin	Run size estimate	Year	Reference
Pajaro R.	1,500	1964	McEwan and Jackson 1996
	1,000	1965	McEwan and Jackson 1996
	2,000	1966	McEwan and Jackson 1996
Carmel R.	20,000	1928	CACSS (1988)
	3,177	1964 – 1975	Snider (1983)
	2,000	1988	CACSS (1988)
	<4,000	1988	Meyer Resources (1988)

Current distribution vs. historical distribution—In 2002, an extensive study was made of steelhead occurrence in most of the coastal drainages between the northern and southern geographic boundaries of the ESU (Boughton and Fish MS). Steelhead were considered to be present in a basin if adult or juvenile *O. mykiss* were observed in any stream reach that had access to the ocean (i.e. no impassable barriers between the ocean and the survey site), in any of the years 2000-2002 (i.e. within one steelhead generation). Of 36 drainages in which steelhead were known to have occurred historically, between 86% and 94% were currently occupied by *O. mykiss*. The range in the estimate of occupancy occurs because three basins could not be assessed due to restricted access. Of the vacant basins, two were considered to be vacant because they were dry in 2002, and one was found to be watered but a snorkel survey revealed no *O. mykiss*. One of the "dry" basins—Old Creek—is dry because no releases were made from Whale Rock Reservoir; however, a land-locked population of steelhead is known to occur in the reservoir above the dam.

Occupancy was also determined for 18 basins with no historical record of steelhead occurrence. Three of these basins—Los Osos, Vicente, and Villa Creeks—were found to be occupied by *O. mykiss*. It is somewhat surprising that no previous record of steelhead seems to exist for Los Osos Creek, near Morro Bay and San Luis Obispo.

The distribution of steelhead among the basins of the region is not much less than what occurred historically, so despite the widespread declines in habitat quality and population sizes, regional extirpations have not yet occurred. This conclusion rests on the assumption that juveniles inhabiting stream reaches with access to the ocean will undergo smoltification and thus are truly steelhead.

Three analyses are made below: 1) A critical review of the historical run sizes cited in the previous status review, 2) an assessment of recent trends observed in the adult counts being made on the Carmel River; and 3) a summary of new sport-fishing regulations in the region.

Review of historical run sizes—Estimates of historical sizes for a few runs were described in the previous status review (Busby et al. 1996), and are here reproduced in Table B.2.8.1.

The recent estimates for the Pajaro River (1,500, 1,000, 2,000) were reported in McEwan and Jackson (1996), but the methodology and dataset used to produce the estimates were not described. CACCS (1988) suggested an annual run size of 20,000 adults in the Carmel River of the 1920s, but gave no supporting evidence for the estimate. Their 1988 estimate of 2,000 adults also lacked supporting evidence. Meyer Resources (1988) provides an estimate of run size, but was not available for review at the time of this writing.

Snider (1983) examined the Carmel River and produced many useful data. In the abstract of his report he gave an estimate of 3,177 fish as the mean annual smolt production for 1964 through 1975; Busby et al. (1996) mistakenly cited this estimate as an estimate of run size. Snider's "3,177" figure may itself be a mistake, as it disagrees with the information in the body of the report, which estimates annual smolt production in the year 1973 as 2,708 smolts, and in the year 1974 as 2,043 smolts. Snider (1983) also gives adult counts for fish migrating upstream through the fish ladder at San Clemente Dam, for the years 1964 through 1975 (data were not reported in Busby et al. 1996; but were apparently the basis for the 22% decline reported by them. See Figure B.2.8.1 for the actual counts.). The mean run size from these data is 821 adults. To make these estimates, visual counts were made twice a day by reducing the flow through the ladder and counting the fish in each step; thus they may underestimate the run size by some unknown amount if fish moved completely through the ladder between counts (an electronic counter was used in 1974 and 1975 and presumably is more accurate). In addition, San Clemente Dam occurs 19.2 miles from the mouth of the river and a fraction of the run spawns below the dam (CDFG biologists estimate the fraction to be one third of the run, based on redd surveys).

Thus, much of the historical data used in the previous status review are highly uncertain. The most reliable data are the Carmel River dam counts, which were not reported in the previous status review. Further analysis of these data are described below.

Abundance in the Carmel River—The Carmel River data are the only time-series for the ESU. The data suggest that the abundance of adult spawners in the Carmel River has increased since the last status review (Figure B.2.8.1.). A continuous series of data exists for 1964 through 1977, although the data are probably incomplete to various degrees for each year (i.e. the counts are probably incomplete, and the year-to-year fluctuations may be mostly due to observation error rather than population variability). A regression line drawn through the data indicates a downward trend, but the trend is not statistically significant (slope = -28.45; $R^2 = 0.075$; $F = 1.137$; $p = 0.304$;). The 22% decline reported by Busby et al. (1996) is apparently based on these data in comparison with the low numbers of the early 1990s.

Continuous data have also been collected for the period 1988 through 2002. The beginning of this time series has counts of zero adults for three consecutive years, then shows a rapid increase in abundance. The trend is strongly upward (see Table B.2.6.3). The time series is too short to make a reliable estimate of mean lambda. The observed positive trend could conceivably be due either to improved conditions (i.e. mean lambda greater than one), substantial immigration or transplantation, or the transient effects of age structure. Improved conditions seem by far the most likely explanation, as the basin has been the subject of intensive fisheries management since the early 1990s. According to the Monterey Peninsula Water Management District, the entity conducting much of the restoration of the basin's steelhead fishery, the likely reasons for the positive trend are due to improved conditions, namely

> "Improvements in streamflow patterns, due to favorable natural fluctuations…since 1995; …actively manag[ing] the rate and distribution of groundwater extractions and direct surface diversions within the basin; changes to Cal-Am's [dam] operations … providing increased streamflow below San Clemente Dam; improved conditions for fish passage at Los Padres and San Clemente Dams …; recovery of riparian habitats, tree cover along the stream, and increases in woody debris…; extensive rescues … of juvenile steelhead over the last ten years … ; transplantation of the younger juveniles to viable habitat

upstream and of older smolts to the lagoon or ocean; and implementation of a captive broodstock program by Carmel River Steelhead Association and California Department of Fish & Game (CDFG), [including] planting … from 1991 to1994." (MPWMD 2001).

Even so, the rapid increase in adult abundance from 1991 (one adult) to 1997 (775 adults) seems too great to attribute simply to improved reproduction and survival of the local steelhead. There are a number of possibilities: substantial immigration or transplantation may have boosted abundance, or perhaps there was a large population of resident trout that has begun producing smolts at a higher rate under improved freshwater conditions. The transplantation hypothesis is thought unlikely: although transplantation of juveniles occurred (in the form of rescues from the lower mainstem during periods in which it was dewatered), CDFG biologists consider the scale of these efforts to be too small to effect the large increase in run size that has been observed. The scale of immigration (i.e. straying) is not known but may be a significant factor. As for the role of resident trout in producing smolts, the phenomenon is known to occur but the environmental triggers have not yet been worked out. One hypothesis, congruent with the Carmel River situation, is that environmental conditions affect growth rate of juveniles, which affects propensity to smolt into the anadromous form.

The rapid increase in adult abundance in the Carmel River system is thus very interesting. At this point two conclusions seem warranted: 1) Upon improvement of freshwater conditions such as those described above, the adult runs are capable of rapid increase in this ESU, due either to resilience of steelhead populations, high stray rates, or ability of resident trout to produce smolts. Either mechanism might allow the fish to rapidly take advantage of improved conditions, suggesting a high potential for rapid recovery in this ESU if the proper actions were taken. 2) Although some component of the increase is probably due to improved ocean conditions, it would be a mistake to assume comparable increases have occurred in other basins of the ESU, as they have not been the focus of such intensive management efforts.

Possible changes in harvest impacts

Since the original status review of Busby et al. (1996), regulations concerning sport fishing have been changed in a way that probably reduces extinction risk for the ESU.

Sport harvest of steelhead in the ocean is prohibited by the California Department of Fish and Game (CDFG 2002a), and ocean harvest is a rare event (M. Mohr, NMFS, pers. comm.), so effects on extinction risk are probably negligible. For freshwaters, CDFG (2002) describes the current regulations. Summer trout fishing is allowed in some systems, often with a two- or five-bag limit. These include significant parts of the Salinas system (upper Arroyo Seco and Nacimiento above barriers; the upper Salinas; Salmon Creek; and the San Benito River in the Pajaro system (All: bag limit five trout). Also included in the summer fisheries is the Carmel River above Los Padres Dam (bag limit two trout, between 10" and 16"). A few other creeks have summer catch-and-release regulations. The original draft of the Fishery Management and Evaluation Plan (CDFG 2000) recommended complete closure of the Salinas system to protect the steelhead there, but the final regulations did not implement this recommendation, allowing both summer trout angling and winter-run catch-and-release steelhead angling in selected parts of the system (CDFG 2002).

The regulations allow catch-and-release winter-run steelhead angling in many of the river basins occupied by the ESU, specifying that all wild steelhead must be released unharmed. There are significant restrictions on timing, location, and gear used for angling. A recent draft Fisheries Evaluation and Management Plan (CDFG 2001b) has been prepared, and argues that the only mortality expected from a no-harvest fishery is from hooking and handling injury or stress. They estimate this mortality rate to be about 0.25% - 1.4%. This estimate is based on angler capture rates measured in other river systems throughout California (range: 5% - 28%), multiplied by an estimated mortality rate of 5% once a fish is hooked. The latter mortality estimate is consistent with a published meta-analysis of hooking mortality (Schill and Scarpella 1997), but experimental studies on the subject—from which the estimates are made—tend to measure mortality only for a period of a few days or a week after capture (e.g. Titus and Vanicek 1988).

The Fishery Management and Evaluation Plan contains no extensive plans for monitoring fish abundance. Although the closure of many areas, and institution of catch-and-release elsewhere, is expected to reduce extinction risk for the ESU, this risk reduction cannot be estimated quantitatively from the existing data, due to the fact that natural abundance is not being measured.

Resident *O. mykiss* considerations

Resident (non-anadromous) populations of *O. mykiss* were assigned to one of three categories for the purpose of provisionally determining ESU membership (See "Resident Fish" in the introduction for a description of the three categories and default assumptions about ESU membership). The third category consists of resident populations that are separated from anadromous conspecifics by recent human-made barriers such as dams without fish ladders. No default assumption about ESU membership was possible for Category 3 populations, so they are here considered case-by-case according to available information.

As of this writing there are few data on occurrence of resident populations and even fewer on genetic relationships. A provisional survey of the occurrence of Category 3 populations in the ESU (see Appendix B.5.2) revealed the following: There are four significant Category 3 populations within the original geographic range of the ESU (Appendix B.5.2)—two in the Salinas system, one behind Whale Rock Dam near Cayucos, and one behind the Lopez reservoir on Arroyo Grande Creek. The two in the Salinas system occur behind the dams on the Nacimiento and San Antonio Rivers, which currently block what were reported to be two of the three principal steelhead spawning areas in the basin (the other being in Arroyo Seco; Titus et al. 2003). Resident populations occur above these dams and stocking is ongoing (Appendix B.5.2). A third major barrier occurs in the headwaters of the Salinas itself; stocking currently occurs above this dam. Steelhead reportedly spawned in these streams before the dam was built, but the runs were probably relatively small and sporadic.

The Whale Rock Reservoir has a resident population that is reported to make steelhead-like runs up several tributaries for spawning. The reservoir has an associated hatchery program; see the previous section above for details on genetic studies, stocking records, *etc*.

According to David Starr Jordan, the area now blocked by the Lopez dam on Arroyo Grande Creek was originally well known as a significant steelhead area (cited in Titus et al. 2003). A resident population currently exists above this dam, and stocking is ongoing (Table B.5.1.1). We are not aware of any studies of the population's genetic affinities.

Minor barriers—defined here as blocking less than 100 sq. mi. of watershed—are numerous within the geographic range of the ESU. A nonzero number of Category 3 populations undoubtedly exist above these barriers but there are insufficient data at the present time to make a comprehensive assessment.

B.2.8.3. New Hatchery Information

The only hatchery stock being considered in this ESU is the one at Whale Rock Hatchery. This stock was assigned to one of three categories for the purpose of determining ESU membership at some future date (See "Artificial Propagation" in the introduction for a description of the three categories and related issues regarding ESU membership). To make the assignment, data about broodstock origin, size, management and genetics were gathered from fisheries biologists and are summarized below.

Whale Rock Hatchery (Whale Rock Steelhead [CDFG])

Whale Rock Reservoir was created in 1961 by placing a dam on Old Creek, 2 km upstream from the coast. Old Creek had supported a large steelhead run previous to construction of the dam and these fish were presumably trapped behind the dam (the creek is usually dewatered below the dam so no population occurs there at all). Whale Rock Hatchery was established in 1992 as an effort to improve the sport fishery in the reservoir after anglers reported a decline in fishing success. The original Whale Rock broodstock (40 fish) were collected at a temporary weir placed in the reservoir at the mouth of Old Creek Cove (Nielsen et al. 1997). Adult fish were trapped in the shallows of the reservoir using nets that are set during late winter and spring as the fish begin their migration upstream from the reservoir into Old Creek. The fish are held in an enclosure while they are monitored for ripeness. Eggs and sperm are collected from fish using non-lethal techniques, and then the adult fish are returned to the reservoir. Fish were originally hatched and raised at the Whale Rock Hatchery located below the dam at the maintenance facility, but are now raised at the Fillmore Hatchery in Ventura County. The fry are cared for until September or November at which time they are released back into the reservoir as 3-5@ fingerling trout.

Broodstock origin and history—Hatchery operations began in 1992 and have been sporadic since. The project is a cooperative venture between CDFG and private parties. Fish were raised in 1992, 1994, 2000, and 2002 (John Bell, personal communication). All broodstock are taken from the reservoir.

Broodstock size/natural population size—An average of 121 fish were spawned. Spawning success has been poor. There are no population estimates for the reservoir and the hatchery fish are not marked.

Management—The current program goal is to increase angling success in Whale Rock Reservoir.

Population genetics—Neilsen et al. (1997) found that significant genetic relatedness occurs between the Whale Rock Hatchery stock and wild steelhead in the Santa Ynez River and Malibu creeks, two basins to the south. She reported a loss of genetic diversity within the hatchery stock.

Category—The hatchery was determined to belong to Category 2 (SSHAG 2003; Appendix B.5.3). Broodstock are taken from the source population, but the small population could easily lead to significant genetic bottlenecks.

B.2.9 SOUTHERN CALIFORNIA STEELHEAD

Primary contributor: David Boughton
(Southwest Fisheries Science Center – Santa Cruz Lab)

B.2.9.1 Summary of Previous BRT Conclusions

The geographic range of the ESU was determined to extend from the Santa Maria River basin near the town of Santa Maria, south to the United States border with Mexico. There is a report of *O. mykiss* populations in Baja California del Norte (Ruiz-Campos and Pister 1995); these populations are thought to be resident trout, but could be found to have an anadromous component with further study (note that they do not lie within the jurisdiction of the Endangered Species Act). NMFS (1997) cites reports of several other steelhead populations south of the border. The southern California ESU is the extreme southern limit of the anadromous form of *O. mykiss*. It was separated from steelhead populations to the north on the basis of a general faunal transition (in the fauna of both freshwater and marine systems) in the vicinity of Point Conception. The genetic differentiation of steelhead populations within the ESU, and from other ESUs in northern California or the Pacific Northwest appears to be great; however the conclusion is based on genetic data from a small number of populations.

Summary of major risks and status indicators

Risks and limiting factors—The original BRT noted that there has been extensive loss of populations, especially south of Malibu Creek, due to urbanization, dewatering, channelization of creeks, human-made barriers to migration, and the introduction of exotic fish and riparian plants. Many of these southern-most populations may have originally been marginal or intermittent (i.e. exhibiting repeated local extinctions and recolonizations in bad and good years respectively). No hatchery production exists for the ESU. The relationship between anadromous and resident *O. mykiss* is poorly understood in this region, but likely plays an important role in population dynamics and evolutionary potential of the fish.

Status indicators—Historical data on the ESU were sparse. The historical run size for the ESU was roughly estimated to be at least 32,000-46,000 (estimates for the four systems comprising the Santa Ynez, Ventura, Santa Clara Rivers, and Malibu Creek; this omits the Santa Maria system and points south of Malibu Creek). Recent run sizes for the same four systems were roughly estimated to be less than 500 adults total. No time series data were found for any populations.

Previous BRT conclusions

The original BRT concluded that that ESU was in danger of extinction, noting that populations were extirpated from much of their historical range (Busby et al. 1996). There was strong concern about widespread degradation, destruction, and blockage of freshwater habitats, and concern about stocking of rainbow trout. The two major areas of uncertainty were 1) lack of data on run sizes, past and present; and 2) the relationship between resident and anadromous forms of the species in the region. A second BRT convened for an update (NMFS 1997) found that the small amount of new data did not suggest that the situation had improved, and the majority view was that the ESU was still in danger of extinction.

Listing status

The ESU was listed as endangered in 1997. The original listing defined the ESU as having its southern geographic limits in Malibu Creek. Two small populations were subsequently discovered south of this point, and in 2002 a notice was published in the Federal Register, extending the range to include all steelhead found in drainages southward to the US border with Mexico.

B.2.9.2 New Data and Updated Analyses

There are four new significant pieces of information: 1) Four years of adult counts in the Santa Clara River; 2) observed recolonizations of vacant watersheds, notably Topanga Creek in Los Angeles county, and San Mateo Creek in Orange county; 3) a comprehensive assessment of the current distribution of *O. mykiss* within the historical range of the ESU (Boughton and Fish MS); and 4) changes in the harvest regulations of the sport fishery. Items (1), (2) and (4) are described further in the analyses section below; item (3) is described here:

Current distribution vs. historical distribution

In 2002, an extensive study was made of steelhead occurrence in most of the coastal drainages within the geographic boundaries of the ESU (Boughton and Fish MS). Steelhead were considered to be present in a basin if adult or juvenile *O. mykiss* were observed in any stream reach that had access to the ocean (i.e. no impassable barriers between the ocean and the survey site), in any of the years 2000-2002 (i.e. within one steelhead generation). Of 46 drainages in which steelhead were known to have occurred historically, between 37% and 43% were still occupied by *O. mykiss*. The range in the estimate of occupancy occurs because a number of basins could not be surveyed due to logistical problems, pollution, or lack of permission to survey on private land. Three basins were considered vacant because they were dry, 17 were considered vacant due to impassable barriers below all spawning habitat; and six were considered vacant because a snorkel survey found no evidence of *O. mykiss*. These snorkel surveys consisted of spot checks in likely-looking habitat and did not involve a comprehensive assessment of each basin.

One of the “dry” basins—San Diego River—may have water in some tributaries—it was difficult to establish that the entire basin below the dam was completely dry. Numerous anecdotal accounts suggest that several of the basins that had complete barriers to anadromy may have landlocked populations of native steelhead/rainbow trout in the upper tributaries. These basins include the San Diego, Otay, San Gabriel, Santa Ana, and San Luis Rey Rivers. Occupancy was also determined for 17 basins with no historical record of steelhead occurrence; none were found to be currently occupied.

Nehlsen et al. (1991) listed the following Southern California stocks as extinct: Gaviota Creek, Rincon Creek, Los Angeles River, San Gabriel River, Santa Ana River, San Diego River, San Luis Rey River, San Mateo Creek, Santa Margarita River, Sweetwater River, and Maria Ygnacio River. The distributional study of 2002 determined that steelhead were present in two of these systems, namely Gaviota Creek (Stoecker and CCP 2002) and San Mateo Creek (a recent colonization; see below). Nevertheless, the current distribution of steelhead among the basins of the region appears to be substantially less than what occurred historically. Except for the small population in San Mateo Creek in northern San Diego County, the anadromous form of the species appears to be completely extirpated from all systems between the Santa Monica Mountains and the Mexican border. Additional years of observations, either of presence or absence, would reduce the uncertainty of this conclusion.

Table B.2.9.1. Estimates from Busby et al. (1996), for run sizes in the major river systems of the southern steelhead ESU.

River basin	Run size estimate	Year	Reference
Santa Ynez	20,000 – 30,000	Historic	Reavis (1991)
	12,995 – 25,032	1940s	Shapovalov & Taft (1954)
	20,000	Historic	Titus et al (MS)
	20,000	1952	CDFG (1982)
Ventura	4,000-6,000	Historic	AFS (1991)
	4,000-6,000	Historic	Hunt et al. (1992)
	4,000-6,000	Historic	Henke (1994)
	4,000-6,000	Historic	Titus et al. (MS)
Matilija Cr.	2,000 – 2,500	Historic	Clanton & Jarvis (1946)
Santa Clara	7,000 – 9,000	Historic	Moore (1980)
	9,000	Historic	Comstock (1992)
	9,000	Historic	Henke (1994)

Recent colonization events

Several colonization events were reported during the interval 1996-2002. Steelhead colonized Topanga Creek in 1998 and San Mateo Creek in 1997 (R. Dagit, T. Hovey, pers. comm.). As of this writing (October 2002) both colonizations persist although the San Mateo Creek colonization appears to be declining. T. Hovey (CDFG, pers. comm.) used genetic analyses to establish that the colonization in San Mateo Creek was made by two spawning pairs in 1997. In the summer of 2002 a dead mature female was found in the channelized portion of the San Gabriel River in the Los Angeles area (M. Larsen, CDFG, pers. comm.). A single live adult was found trapped and over-summering in a small watered stretch of Arroyo Sequit in the Santa Monica Mountains (K. Pipal and D. Boughton, UCSC and NMFS, pers. comm.). The "run sizes" of these colonization attempts are of the same order as recent "run sizes" in the Santa Clara system—namely, less than five adults per year. Each of the four colonization events reported above occurred in a basin in which the presence of steelhead had been documented historically (Titus et al. MS).

Two significant analyses exist: 1) A critical review of the historical run sizes cited in the previous status review, and 2) A few new data on run size and population distribution in three of the larger basins.

Review of historical run sizes

Few quantitative data exist on historical run sizes of southern steelhead. Based on the available information at the time, the previous status review made rough estimates for three of the large river systems (Table B.2.9.1), and a few of the smaller ones (Busby et al. 1996).

The Santa Ynez.—The run size in the Santa Ynez system—probably the largest run historically—was estimated to originally lie between 20,000 and 30,000 spawners (Busby et al. 1996). This estimate was based primarily on four references cited in the status review: Reavis

(1991) (20,000-30,000 spawners), Titus et al. (MS) (20,000 spawners), Shapovalov and Taft (1954) (12,995-25,032 spawners), and CDFG (1982) (20,000 spawners). Examination of these references revealed the following: Reavis (1991) asserted a run size of 20,000-30,000, but provided no supporting evidence. Titus et al. (MS) reviewed evidence described by Shapovalov (1944), to be described below. Shapovalov and Taft (1954) did not address run sizes in this geographic region; the citation is probably a mis-citation for Shapovalov (1944). CDFG (1982) makes no reference to salmonid fishes in southern California.

Entrix (1995) argued that the estimate of 20,000 – 30,000 is too large. They argued that the only direct observations of run size are from Shapovalov (1944), an assertion that appears to be correct. These data are based on a CDFG employee's visual estimate that the 1944 run was "at least as large" as runs in the Eel River (northern California), which the employee had observed in previous years. Estimated run sizes for the Eel River ranged between 12,995 and 25,032 during the years 1939 to 1944 (Shapovalov 1944), and this has thus been reported as the estimated run size of the Santa Ynez. Entrix (1995) observed, however, that the employee who made the comparison was only present at the Eel River during two seasons, 1938-39 and 1939-40. The estimates for run sizes in those years were 12,995 and 14,476 respectively, which suggests that a more realistic estimate for the Santa Ynez run of 1944 would be 13,000-14,500. Taking this chain of reasoning to its logical conclusion, the range 13,000 – 14,500 should be regarded as a minimum run size for the year in question, since the employee used the phrase "at least as large."

It is perhaps useful to place the year 1944 in context, since expert opinion about run size is based solely on observations made in that year. Entrix (1995) report that 1944 occurred toward the end of a wet period, which may have provided especially favorable spawning and rearing conditions for steelhead. Rainfall data from Santa Barbara County's historical records give a different picture from Entrix (1995): only two of the preceding eight years (1940 and 1943) were wetter than the 107-year average for the area (M. Capelli, person. comm.). 1944 was near average; otherwise rainfall was below average.

In addition, the year 1944 seems to have occurred toward the end of a period in which extensive rescues of juvenile steelhead had been made during low-flow years (Shapovalov 1944, Titus et al. MS). Over the interval 1939-1946, a total of 4.3 million juveniles were rescued from drying portions of the mainstem, and usually replanted elsewhere in the system. This averages to about 61,400 juveniles rescued per year. Assuming that rescue operations lowered the mean mortality rate as intended, during the 1939-1946 interval the Santa Ynez population may have increased somewhat (or failed to undergo a decline) due to the rescue operations. A rough estimate of magnitude can be made: Assuming deterministic population growth (as opposed to stochastic), and a survival to spawning of about 1%, the rescues would have increased the run size by about 4% per generation. High environmental stochasticity in survival of the rescued fish and in the overall population growth—which almost certainly was the case—would have reduced the effect size to be much lower than 4%.

There is a counter argument to the argument that the 1944 estimate is too high; namely that it is too low. The estimate was not made until 24 years after a significant proportion of spawning and rearing habitat had been blocked behind dams. The Santa Ynez system currently has three major dams on the mainstem that block portions of spawning and rearing habitat. The middle dam (Gibraltar) was built in 1920, and blocked access to 721 kilometers of stream, much of which was widely regarded to be high-quality spawning and rearing habitat (Table B.5.1.1; Titus et al MS). At that time, no estimates of run size had been made for the Santa Ynez. An upper dam (Juncal) was constructed in 1930 and may have had a negative effect on run size through reduction of flows to the lower mainstem. Only the lower dam (Cachuma or Bradbury) was built late enough (1953) to not cause the 1944 estimate to be a biased estimate of historical run size.

Ventura.—According to Titus et al. (MS), the Ventura River was estimated to have a run size of 4,000-5,000 adults during a normal water year. This estimate was made in 1946, although it is likely that the estimate is an expert opinion based on numerous years of observation. The system had received numerous plantings of juveniles in the preceding period (27,200 in 1943, 20,800 in 1944, and 45,440 in 1945, as well as 40,000 in 1930, 34,000 in 1931, and 15,000 in 1938). These rescues probably had small effect, for similar reason as those cited above for the Santa Ynez. As in the Santa Ynez, anecdotal accounts suggest that run sizes declined precipitously during the late 1940s and 1950s, due possibly to both drought and to anthropogenic changes to the river system such as dam construction. Similar considerations apply to the estimate made by Clanton and Jarvis (1946), of 2,000-2,500 adults in the Matilija basin, a major tributary of the Ventura River.

Santa Clara.—Moore's (1980) estimate of 9,000 spawners in the Santa Clara basin is an extrapolation of the estimate of Clanton and Jarvis' (1946) estimate for Matilija Creek. He assumed similar levels of production per stream mile in the two systems, and noted that at least five-times more spawning and rearing habitat exists in the Santa Clara. Moore (1980) regarded his estimate as biased downward, because although it included the major spawning areas (Santa Paula, Sespe, and Piru creeks), it omitted numerous small side-tributaries.

Ed Henke (cited in NMFS 1997) stated that abundance of steelhead in the Southern California ESU was probably about 250,000 adults prior to European settlement of the region. His argument is based on historical methods of research involving interviews of older residents of the area as well as written records. The original analysis producing the cited estimate is part of ongoing research and was not made available for review at the time of this writing (E. Henke, pers. comm.).

In summary, the estimates of historical run sizes for this steelhead ESU are based on very sparse data and long chains of assumptions that are plausible but have not been adequately tested. It seems reasonable to say that the existing estimates are biased upward or downward by some unknown amount. It is certainly clear from the historical record that adult run sizes of the past could be 2 or 3 orders of magnitude greater in size than those of recent years, but the long-term mean or variance in run size is not known with any reasonable precision at all. Assuming that spawning and rearing success are related to rainfall, the variance between years was likely high due to climatic variability in southern California; and variance among decades high due to the Pacific Decadal Oscillation. In addition, long-term climate change in the region likely causes the running mean of run size (whatever it may be) to exhibit drift over time. If one were to be interested in the true potential productivity of these systems, much would be learned by some targeted field studies on the current habitat-productivity relationships for the fish, and by studies of the influence of climate, water management practices, and their interaction. It does not seem likely that further historical research will turn up information useful for making more refined estimates, despite the fact that it is useful for determining where exactly the fish occurred.

Recent run sizes of large river systems

It seems likely that the larger river systems were originally the mainstay of the ESU. Large river systems that harbored steelhead populations in the past are (from north to south) the Santa Maria, the Santa Ynez, the Ventura, the Santa Clara, the Los Angeles, the San Gabriel, the Santa Ana, and possibly the San Diego. Of these eight systems, the data suggest that steelhead currently occur in only four—the Santa Maria, Santa Ynez, Ventura, and Santa Clara.

The Santa Maria—There do not appear to be any estimates for recent run sizes in the Santa Maria system. Twitchell Dam blocks access to a significant proportion of historical spawning habitat, the Cuyama River, one of the two major branches of the Santa Maria. The other major branch, the Sisquoc River, appears to still have substantial spawning and rearing habitat that is accessible from the ocean; juvenile steelhead have recently been observed in these areas (Cardenas 1996, Kevin Cooper, Los Padres NF, pers. comm.).

The Santa Ynez—Most of the historical spawning habitat is blocked by Cachuma and Gibraltar Dams. However, extensive documentation exists for steelhead/rainbow trout populations in a number of ocean-accessible sites below Cachuma dam (Table B.2.9.2). These are Salsipuedes/El Jaro Creeks, Hilton Creek, Alisal Creek, Quiota Creek, San Miguelito Creek, and three reaches in the mainstem (Hanson 1996, Engblom 1997, 1999, 2001). Various life stages of steelhead, including upstream migrants and smolts, have been consistently observed at some of these sites (see Table B.2.9.2), suggesting the occurrence of persistent populations. Run sizes are unknown, but likely small (<100 adults total), implying the populations are not viable over the long term. A third dam, Juncal Dam, occurs above the other two dam in the watershed, and is reported to support a small population of land-locked steelhead that annually enter the reservoirs' tributaries to spawn (M. Capelli, pers. comm.)

The Ventura—There are no estimates of recent run sizes in the Ventura River. Casitas Dam on Coyote Creek and Matilija Dam on Matilija Creek block access to significant portions of the historical spawning habitat. There are recent individual reports of sightings of steelhead in the Ventura River and San Antonio Creek (M Capelli, 1997; C. Zimmerman 2000, 2001), but no quantitative estimates.

The Santa Clara—A few estimates of recent run sizes exist for the Santa Clara system, due to the presence of a fish ladder and counting trap at the Vern Freeman Diversion Dam on the mainstem. This diversion dam lies between the ocean and what is widely believed to be one of the largest extant populations of steelhead in the ESU (the Sespe Canyon population). The run size of upstream migrants was one adult in each of 1994 and 1995, two adults in 1996, and no adults in 1997. No data have been collected since that date, and the fish ladder is thought to be dysfunctional.

Harvest impacts

Since the original status review of Busby et al. (1996), regulations concerning sport fishing have been changed in a way that may potentially reduce extinction risk for the ESU.

Sport harvest of steelhead in the ocean is currently prohibited by the California Department of Fish and Game (CDFG 2002a), and ocean harvest is a rare event (M.

Mohr, NMFS, pers. comm.). For freshwaters (CDFG 2002b), summer-fall catch-and-release angling is allowed in Piru Creek below the dam; San Juan Creek (Orange County); San Mateo Creek (one section); Santa Margarita River and tributaries; and Topanga Creek. Year-round catch and release is allowed in the San Gabriel River (below Cogswell Dam); and Sespe Creek and tributaries. All the above are historical steelhead streams and many of the stretches open to fishing are potentially used both by anadromous runs and by resident populations.

Year-round trout fisheries are allowed in Calleguas Creek and tributaries (limit 5); Piru Creek above the dam (limit 2); San Luis Rey River (limit 5); Santa Paula Creek above the falls (limit 5); the Santa Ynez River above Gibraltar Dam (limit 2); Sisquoc River (limit 5); and Sweetwater River (limit 5). With the exception of the Sisquoc River, these take-fisheries appear to be isolated from the ocean by natural or human-made barriers. Except for Calleguas Creek and possibly the Sweetwater, the above drainages are listed as historical steelhead streams by Titus et al. (MS). It is certainly possible and indeed likely that some currently harbor native trout with the potential to exhibit anadromy

At catch-and-release streams, all wild steelhead must be released unharmed. There are significant restrictions on gear used for angling. The CDFG monitors angling effort and catch-per-unit-effort in selected basins by way of a “report card” system in which sport anglers self-report their catch, gear used, and so forth, and in selected other basins by way of creel censuses.

Although the closure of many areas, and institution of catch-and-release elsewhere, is expected to reduce extinction risk for the ESU, this risk reduction cannot be estimated quantitatively from the existing datasets (due to the fact that natural abundance is not being estimated). After the Federal listing decisions, NMFS requested that CDFG prepare a Fishery Management and Evaluation Plan (FMEP) for the listed steelhead ESUs in California. This has not yet been done for the southern California ESU, so the rationale for the set of regulations summarized above is not transparent.

Resident *O. mykiss* considerations

Resident (non-anadromous) populations of *O. mykiss* were assigned to one of three categories for the purpose of provisionally determining ESU membership (See “Resident Fish” in the introduction for a description of the three categories and default assumptions about ESU membership). The third category consists of resident populations that are separated from anadromous conspecifics by recent human-made barriers such as dams without fish ladders. No default assumption about ESU membership was possible for Category 3 populations, so they are here considered case-by-case according to available information.

As of this writing there are few data on occurrence of resident populations and even fewer on genetic relationships. A provisional survey of the occurrence of Category 3 populations in the ESU (see Table B.5.1.1) revealed the following: There are numerous Category 3 populations within the original geographic range of the Southern California ESU. All of the larger watersheds originally inhabited by the ESU now have major barriers completely blocking substantial portions of habitat (Table B.5.1.1; a major barrier is defined as a complete barrier to migration that has greater than 100 sq. mi. of watershed area lying above it). In the watershed of the Santa Maria River, 71% of total stream kilometers are above Twitchell Dam. The Santa Clara watershed has 99% of stream kilometers above Vern Freeman diversion dam. This facility has a fish ladder, but the ladder is currently dysfunctional due to channel migration which has disconnected the ladder intake from the river's thalweg, combined with deficient quantities and configurations of water releases through the facility (M. Whitman, CDFG hydraulic engineer, personal communication). The Santa Ynez watershed, which probably originally harbored the strongest run of steelhead in the southern California ESU, has 58% of its stream kilometers above Cachuma dam. In each of these cases the historical record has reports of steelhead ascending to and spawning in areas that are now blocked behind the above-mentioned dams (Titus et al. 2003). In the case of the Santa Ynez, adult *O. mykiss* have been observed to make "steelhead-like" runs from the uppermost reservoir (behind Juncal dam) into the North Fork Juncal and the upper Santa Ynez for at least the past seven years (personal communication, Louis Andolora, dam tender at Juncal).

All the large watersheds further south have major barriers blocking substantial portions of stream habitat. Consequently, in the set of major watersheds originally inhabited by the ESU, at least 48% of stream kilometers are now behind barriers impassable to anadromous fish (the value is probably somewhat higher due to minor barriers not considered in Table B.5.1.1). At least 11 of these 15 major watersheds are known to have resident populations above the barriers (Table B.5.1.1).

We do not know much about the genetic relationships of these resident populations. There is one study of genetic relationships among hatchery stocks, anadromous fish, and resident populations above barriers (Nielsen et al. 1997). The study used selectively-neutral genetic markers to assess genetic distances among the various categories of fish (anadromous, residualized, hatchery, etc.) but the results were inconclusive. However, according to the provisional survey described in Table B.5.1.1, at least 7 of the 11 watersheds with resident populations above major barriers are currently being stocked with hatchery fish. It is not clear whether these stocked fish have successfully interbred with the native fish; whether such interbreeding would have led to significant gene flow between the introduced and native fish; or to what extent the local adaptations of the native fish would have been maintained by selection even if gene flow occurred.

Table B.2.9.2. Presence of steelhead in the lower Santa Ynez River system (*caught in upstream migrant trap).

Tributary	Redds	<6"	>6"	Smolts	Adults	Unspec	Year (spr.)	Source
Salsipuedes/El Jaro		Y	Y	Y	Y*		1994	Hanson 1996
				Y	Y*		1995	Hanson 1996
	Y	Y	Y	Y	Y*		1996	Hanson 1996, Engblom 1997
	Y	Y	Y	Y	Y*		1997	Engblom 1997
	Y	Y	Y		Y*		1998	Engblom 1999
	Y	Y	Y		Y*		1999	Engblom 1999
					Y*		2000	Engblom 2001
		Y	Y	Y	Y*		2001	Engblom 2001
Hilton Creek		N	N		Y*		1994	Hanson 1996
		Y	Y†	Y	Y*		1995	Hanson 1996
				N	Y*		1996	Hanson 1996, Engblom 1997
	N	Y	Y	N	Y*		1997	Engblom 1997
	Y	Y			Y*		1998	Engblom 1999
					N*		1999	Engblom 1999
		Y	Y		Y*		2001	Engblom 2001
Alisal Creek		Y	Y		Y*		1995	Hanson 1996
Nojoqui Creek		N	N		N*		1994	Hanson 1996
				N	N*		1995	Hanson 1996
				N			1997	Engblom 1997
		N	Y		Y*		1998	Engblom 1999
					N*		1999	Engblom 1999
Quiota Creek (& trib)	Y		Y		N*		1995	Hanson 1996
		Y	Y				1994	Hanson 1996
		Y					1998	Engblom 1999
		Y	Y				2001	Engblom 2001
San Miguelito Creek		Y	Y				1996	Hanson 1996
	Y			Y			1997	Engblom 1997
		Y		N	N*		1998	Engblom 1999
	Y			N	N*		1999	Engblom 1999
Mainstem/Hwy 154		Y	Y				1995	Hanson 1996
		Y	Y				1996	Hanson 1996
					Y		1994	Hanson 1996
		Y	Y				1998	Engblom 1999
	Y						1999	Engblom 1999
		Y	Y				2001	Engblom 2001
Mainstem/Refugio		Y	Y				1995	Hanson 1996
		N	Y				1996	Hanson 1996
		Y	Y				1998	Engblom 1999
	Y	N	Y				1999	Engblom 1999
		Y	Y				2001	Engblom 2001
Mainstem/Alisal reach		Y	Y				1995	Hanson 1996
		N	Y				1996	Hanson 1996
		Y	Y				1998	Engblom 1999
		Y	Y				1999	Engblom 1999
		Y	Y				2001	Engblom 2001
Mainstem/Cargasachi		N	N				1995	Hanson 1996
		N	N				1996	Hanson 1996